Salivary Secretion

⇒ Saliva is secreted primarily by <u>three pairs of glands</u>: the parotid, the submandibular and the sublingual glands; in addition, there are many small buccal glands.

⇒ **About 1500 ml** of saliva is secreted per day that contains proteins (enzymes as ptyalin and mucin) and electrolytes (K^+, HCO_3^-, Na^+ and Cl^-).

⇒ The pH of saliva from resting glands is about 7.0.

⇒ Each salivary gland is formed of **acini,** which secrete a primary secretion that flows through the **salivary ducts**, which open into the oral cavity.

⇒ <u>The acinus is formed of two types of secretory cells:</u>

(1) **Serous cells:** Which secrete serous (watery) secretion containing ptyalin (alpha- amylase enzyme).

(2) **Mucous cells:** Which secrete mucous (viscous) secretion containing mucin.

⇒ The parotid glands acini are serous. They form about 25% of saliva.

⇒ The sublingual glands acini are mixed. They form about 5% of saliva. The submandibular glands acini are mixed. They form about 70% of salivary secretion ***).***

⇒ The buccal glands secrete only mucous.

Mechanism of salivary secretion

<u>Salivary secretion consists of two stages;</u>

The first stage: Involves the acini, which secrete a primary secretion that contains ptyalin and/or mucin in a solution of ions which shows no great difference from extracellular fluid.

The second stage: As the primary secretion flows through the ducts, the ionic composition of the saliva is markedly modified **by the following processes:**

(1) **Sodium ions (Na^+)** are actively reabsorbed, and potassium ions (K^+) are actively secreted.

However, sodium reabsorption is higher than potassium secretion in the salivary ducts which causes chloride ions (Cl^-) to be passively reabsorbed.

Therefore, the sodium ion and chloride ion concentrations of the saliva are markedly reduced whereas the potassium ion concentration becomes increased during passage through the ducts ***(Fig 1).***

Aldosterone increases the K^+ concentration and reduces the Na^+ concentration of saliva in an action similar to its action on the kidney.

(2) **Bicarbonate ions (HCO_3^-)** are actively secreted into the

ely impermeable to water. Therefore, ne mouth is hypotonic to plasma.

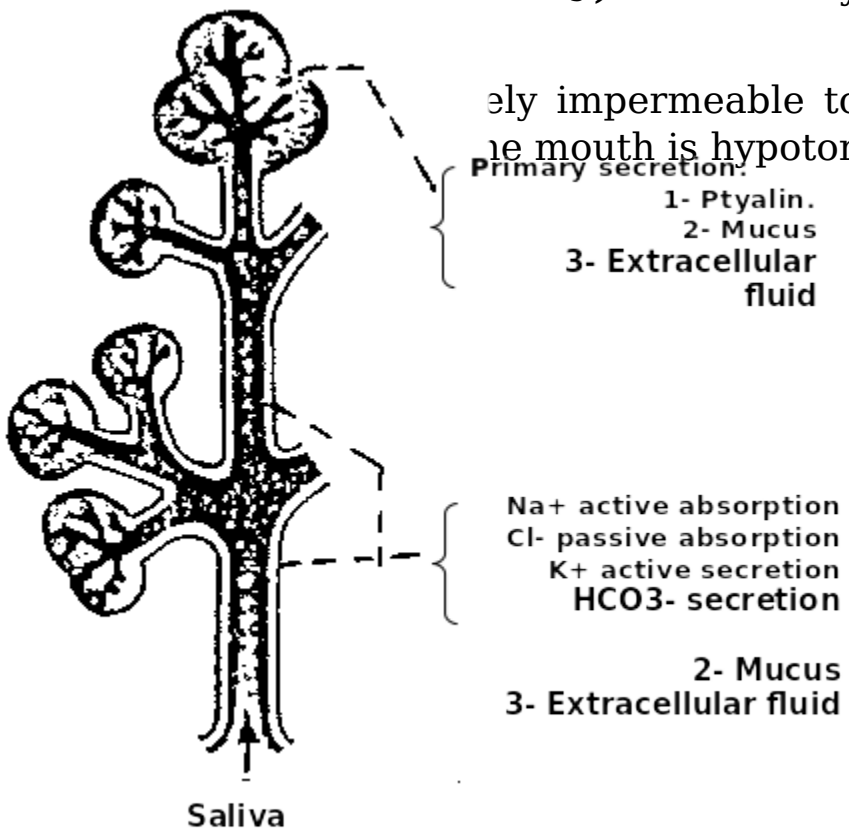

Fig. (1): Formation and secretion of saliva by salivary gland

The net result of these transport processes under resting conditions makes the concentration of Na^+ and Cl^- in saliva much less, whereas the concentrations of K^+ and $HCO3^+$much more than in plasma.

During maximal salivation as a result of parasympathetic stimulation: As the rate of secretion increases, there is less time for NaCl to be extracted and the tonicity of the saliva rises, but it always stays somewhat hypotonic with respect to plasma. (because ductal modification of the saliva is markedly reduced by the rapid flow in a short time).

Functions of Saliva

1. Articulation:Keeping mouth moist facilitates movements of the lips and tongue during speech
2. Buffer function: the saliva contains bicarbonate which neutralizes acids present in food or produced by bacteria in mouth (so prevent dental caries) or even the gastric acid if gastric juice is abnormally regurgitated into the esophagus (so relieve heartburn).Thus, help to maintain oral pH at about 7.0.
3. Cleaning function: maintaining healthy oral mucosa by:
    a. Washing away pathogenic bacteria& food remnants.

b. Lysozyme attacks the walls of bacteria.
c. Antibodies (IgA) destroy pathogenic bacteria.
d. Lactoferrin is a bacteriostatic.

4. Cooling function: Cooling of hot food (protective function).
5. Deglutition: Saliva contains mucins (glycoproteins) that lubricates the food, facilitating its swallowing
6. Digestion:
   - Ptyalin (α-amylase): cleaves α-1,4-glycosidic bonds of starch.Its optimum pH 7. Products of digestion: α dextrins,maltotriose & maltose.
   - Lingual lipase: act on Triglycerides. Its optimum pH is low, so it remains active in stomach.
7. Excretion of waste products as fluorides, urea, lead and mercury.
8. Facilitate the stimulation of taste buds: Saliva acts as a solvent for the molecules that stimulate taste receptors.

Saliva protects oral mucosa:

1. Cooling hot foods.
2. Neutralizing acid :
   a) The buffers in saliva help maintain oral pH at about 7.0.
   b) Buffers neutralize the gastric acid, and relieve heartburn if gastric juice is abnormally regurgitated into the esophagus.
3. Maintaining healthy oral mucosa through:
   i. Washing away pathogenic bacteria, and any food remnants, which provide nutrients for bacterial growth.
   ii. Lysozyme attacks the walls of bacteria.
   iii. Antibodies (immune globulin IgA) destroy oral pathogenic bacteria.
   iv. Lactoferrin is a bacteriostatic.

Saliva protects teeth:

a. The buffers in saliva help to keep the oral pH at about 7.0. At this pH, the saliva is saturated with calcium and so the teeth do not lose calcium because Ca^{++} dissolves in acidic medium and precipitate in alkaline medium . Loss of Ca^{++} from the teeth enamel leads to dental caries.

b. Fluoride protects the teeth enamel. It is added in minute amounts to drinking water to be excreted in saliva.

c. Proline-rich proteins protect teeth enamel and bind toxic tannins.

In the absence of salivation **(xerostomia)**, the dry oral-mucosa becomes ulcerated and infected, with a higher incidence of dental caries.

Control of Salivary secretion

-In humans salivary glands are continuously secreting. Increased secretion however, takes place when food is introduced into the mouth. It is well known also that sight or smell and even thought of food increases salivary secretion.

-Stimulation of salivary secretion is entirely under neural control through autonomic nervous system reflexes.

Innervation of salivary glands:

The salivary glands are supplied by both efferent parasympathetic cholinergic, and sympathetic adrenergic fibres:

I) ***Parasympathetic efferent fibres:***

a) Sublingual and submaxillary (Submandibular) salivary glands:

The preganglionic fibres arise from the superior salivary nucleus in the medulla and run in the chorda tympani branch of the facial nerve, to relay in the submandibular autonomic ganglion. Postganglionic fibres arise from this ganglion, and pass to supply both salivary glands ***(Fig 2).***

b) Parotid gland:

The preganglionic fibres arise from the inferior salivary nucleus in the medulla and run in the glossapharangeal nerve to relay in the otic ganglion. Postganglionic fibres arise from this ganglion and pass to supply the parotid gland.

-Stimulation of the parasympathetic nerve supply to the salivary glands causes profuse secretion of watery saliva, which is high in electrolytes with a relatively low content of organic material.

- Associated with this secretion there is marked vasodilatation in the gland which is **due to local release of VIP**. VIP is a cotransmitter with acetylcholine in some postganglionic parasymp cholinergic blocking

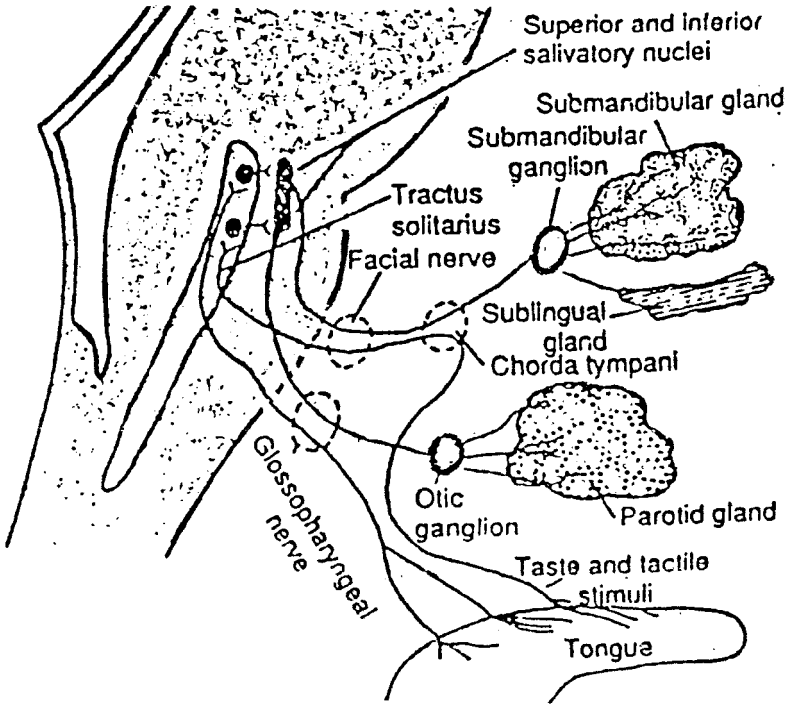

Fig. (2): Parasympathetic nervous regulation of salivary secretion.

II) ***Sympathetic efferent fibres:***

From the lateral horn cells of the first and second thoracic segments of the spinal cord, preganglionic fibres arise to relay in the superior cervical ganglion. Postganglionic fibres arising from this ganglion reach all the salivary glands along the wall of their blood vessels.

-Stimulation of the sympathetic nerve supply to the salivary glands causes vasoconstriction, and secretion of a small amount of saliva rich in organic constituents.

The secretion of saliva can occur in response to conditioned or unconditioned stimuli.

1- Unconditioned reflexes:

Food in the mouth causes reflex secretion of saliva: Taste, tactile, and thermal stimuli from the mouth, leads to impulses that excite the superior and inferior salivary nuclei, resulting in reflex increase in salivary secretion.

Salivation also occurs in response to reflexes originating in the stomach and upper intestine as a result of swallowing of very irritating foods, or due to some gastrointestinal abnormality. The

swallowed saliva helps to remove the irritating factor in the gastrointestinal tract by diluting or neutralizing it.

2- Conditioned reflexes:

Sight, smell, hearing, preparation of food and even thinking of food, results in reflex increase in the secretion of saliva. The impulses arrive to the salivary nuclei from the cerebral cortex, in response to any conditioned stimulu. The appetite area in the hypothalamus receives signals from taste and smell areas of the cerebral cortex or amygdala. It excites the salivary nuclei to increase salivary secretion also.